DYNAMICS OF FICTITIOUS EARTH'S SATELLITES WITH POSSIBLE PAST VALUES OF THE ECLIPTIC

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Abstract. According to many authors, there is no reason to believe that inner planets never had satellites in the past. Indeed, Alfvén and Arrhenius (1972), Burns (1973), Ward and Reid (1973), etc, explain their disappearance using essentially tidal effects which cause secular variations in the semimajor axes. Here, taking into account only gravitational forces, we show that the extinction or the non existence of Earth's satellites could also be related to some strong instabilities which increase the eccentricities e to prohibitive values.

Variation Of The Eccentricity

According to Laskar et all (1993), depending on the spin, the past obliquities ϵ of the inner planets could have varied in a large interval. In the case of Earth, this was a possibility in the absence of the Moon. First, let's see the dynamics of fictitious Earth's satellites, in this situation (without Moon). The main perturbations on a single massless satellite are the Sun and the oblateness of the planet. At the distance when the magnitude of these two perturbations balance, the satellite's semimajor axis a has a critical value (a_{crit}). In order to study the dynamics of this problem we did a lot of numerical integrations of equatorial satellites placed in almost circular orbits, considering several values of a and ϵ. Our analysis is similar to the case described in Yokoyama (1998). Then we show that when ϵ is high ($\geq 40^0$) and depending on the initial a, the eccentricity e suffers strong variation, which cause collision of the satellite with Earth and usually this occurs in a few hundred of years. We also show that, if ϵ is $\geq 40^0$ and the semimajor axis a of the satellite is near a_{crit}, a large chaotic zone appears which again gives prohibitive values for e. Finally it is worth mentioning that this chaotic zone can occur at different distances from the planet, since J_2 (oblateness coefficient), depends on the Earth's spin. Therefore considering this fact and also possible high values of ϵ we show the existence of significant regions where e can reach prohibitive values. Now, let's see a new situation when we include the Moon. This time, we study the behaviour of a massless satellite disturbed by the Moon, Sun and the Earth's oblateness. In spite of the mass ratio, note the similarity between this problem and Triton-Neptune and some of its inner satellites (Triton's retrograde orbit is spiraling, Chyba et all 1989). The exact Earth-Moon history is not known (Touma and Wisdom 1998) but here, for the past values of ϵ and Moon's orbit, we basically consider the results given in Goldreich (1966) and Touma and Wisdom (1994). Taking several different values for Moon's semimajor axis a_L and also for a, we integrated a grid of initial a,a_L where satellites are placed on the Earth's equator in circular orbits. As we said before, Moon's inclination and ϵ at several Earth-Moon distances, are given

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in Goldreich (1966) or Touma and Wisdom (1994). The numerical integrations of this grid of semimajor axes, give a series of interesting figures showing very large regions where the eccentricity attains values about 0.8, 0.9, in less than 500 years. Some of these instabilities are related to Kozai resonances and others to orbital resonances. As a conclusion, like in the previous case, there are significant regions of the phase space where satellites cannot survive. We also derived the averaged equations for this problem and some additional integrations (also for Triton-Neptune system) is being carried out. The full results should be reported elsewhere.

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